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CERTIFICATE

This certificate is issued in support of an application for Patent registration in a country outside New Zealand pursuant to the Patents Act 1953 and the Regulations thereunder.

I hereby certify that annexed is a true copy of the Provisional Specification as filed on 28 October 2003 with an application for Letters Patent number 529182 made by Colin Brian Nicholson.

I further certify that the Provisional Specification has since been post-dated to 20 December 2003 under Section 12(3) of the Patents Act 1953.

Dated 11 January 2005.

Neville Harris
Commissioner of Patents, Trade Marks and Designs

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PATENTS ACT 1953
PROVISIONAL SPECIFICATION

Self-propelled vehicle for use in a conduit

I, Colin Brian Nicholson a New Zealand citizen of 479 Oropi Rd, RD 3, Tauranga do hereby declare this invention to be described in the following statement:

Self-propelled vehicle for use in a conduit

TECHNICAL FIELD

The invention relates generally to self-propelled vehicles for use in conduits, and in particular to apparatus for cleaning conduits.

BACKGROUND ART

NZ patent no. 318456 describes a vehicle for use in a tubular conduit (e.g. for inspection or maintenance purposes) that includes two bodies interconnected by a hydraulic ram for moving the bodies towards and away from each other. Each of the bodies is supported upon a multiplicity of resilient bristles and by relative movement of the bodies, the vehicle is able to propel itself through the conduit in a stepwise manner.

This vehicle has a number of drawbacks, for example, because it relies upon frictional engagement caused by deflection of the bristles it is only suited for use over a relatively small range of diameters and for any given pipe diameter there is no means for increasing the frictional engagement. Additionally, reorientation of the bristles is necessary to change the direction of travel.

US patent no. 5 080 020 describes a vehicle having two bodies connected by an elastic member, each body having a bladder by which it can be fixed inside the conduit. The vehicle may be stepped along the conduit by alternately fixing the bodies while expanding the bladder to move the bodies towards and away from each other by means of the elastic member. This vehicle is also unsuited to provide a strong frictional engagement with the conduit, such as may be required when encountering an obstruction in the conduit, since the bladder lacks rigidity. The bladder is also vulnerable to damage by obstructions in the conduit.

It is an object of the present invention to address the foregoing problems or at least to provide the public with a useful choice.

Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

Any publication cited in this specification is hereby incorporated by reference, however this does not constitute an admission that the document forms part of the common general knowledge in the art, in New Zealand or in any other country. The applicant reserves the right to challenge the pertinency of any publication cited herein, or to challenge the accuracy of any assertion made in a cited publication. As used herein, the word "comprises" means "includes, but is not limited to" and its derivatives have a corresponding meaning.

DISCLOSURE OF THE INVENTION

According to one aspect of the present invention there is provided a vehicle comprising:

a forward and a rearward member, each member being provided with wall-engaging means for selectively engaging a wall of the conduit to hold the respective member in a stationary position within the conduit;

extensible means connecting the members for relative movement of the forward member toward and away from the rearward member, and characterised in that

the wall-engaging means includes a substantially inflexible wall-engaging mechanism for extending feet outwardly for frictional engagement with the conduit.

The wall-engaging mechanism preferably includes inflexible means such as legs to which the feet are fixed or upon which the feet are formed. Preferably the legs are pivotally mounted for extension and retraction and the feet are pivotally fixed to the

legs. The actuator for the wall-engaging mechanism may also be inflexible (e.g. driven by an incompressible hydraulic fluid) and is preferably a linear actuator. Preferably the wall-engaging mechanism is remotely controlled for extending and retracting the feet, allowing the apparatus to propel itself in a stepwise manner through the conduit. The wall-engaging mechanism mounting the feet on the rearward member preferably includes a "self-servo" action automatically increasing the frictional engagement between the feet and the conduit when a rearwardly directed force is applied to the rearward member when the feet are engaged.

The vehicle is thus able to travel in either direction along a pipe and may accommodate the presence of detritus in the pipe. The robust and adaptable nature of the substantially inflexible wall engaging mechanism permits high frictional forces to be applied via the feet. Thus, positive movement of the vehicle may be maintained to overcome obstruction, or to aid carrying / pulling heavy loads, e.g., smaller cameras or cabling. According to the environmental conditions in the conduit, the feet may also be rigid and inflexible or alternatively, be provided with a high friction contact surface, such as rubber. Thus, in one embodiment, the feet may include a flexible, resilient material for abutting the wall of the conduit.

Preferably the extensible means comprises a linear actuator. The extensible means, for example, may be a fluid powered ram which is either single-acting with a spring return or double acting.

The vehicle preferably further includes means for loosening material accumulated in the conduit and in a preferred embodiment this is a rotary cutter mounted at the front of the forward member. Preferably a water spray is provided at the cutter for lubrication, cleaning and aiding removal of the loosened material. Means may also be provided for removing the loosened material e.g. a vacuum line.

At least one of the members preferably further includes wheels for engaging the walls

of the pipe to support the apparatus. The wheels may be retractable, and in the preferred embodiment, the apparatus includes a mechanism for retracting the wheels when extending the wall-engaging means.

According to another aspect of the present invention there is provided a device for transporting material in a first direction through a conduit, the device including:

an elongate shaft adapted to be fixed to means for reciprocating the shaft in the first direction and an opposing second direction;

a plurality of paddles for impinging the material, the paddles being fixed to the shaft at longitudinally spaced positions, each paddle being adapted to close so as to occlude at least a lower section of the conduit when moved in the first direction and to open so as not to occlude at least the lower section of the conduit when moved in the second direction such that material is transferred in the first direction between adjacent paddles.

The shaft may be rigid for use in a cylindrical conduit. Alternatively, means may be provided to accommodate a degree of curvature in the conduit e.g. a flexible shaft or flexible joints between sections of the shaft etc.

This transport device may be fixed to the vehicle substantially as described above, the shaft being fixed to the rearward member. The device may be actuated by reciprocation of the rearward member, or may be fixed to the rearward member by a reciprocating actuator. Alternatively the device may be fixed to other reciprocating means of a known type, manually or power-operated.

Each paddle is preferably fixed to the shaft by a pivot. Preferably the axes of each pivot are coplanar and adapted to extend horizontally in use. For use in a cylindrical conduit the paddles are at least partly circular e.g. semi-circular or circular. For other regular shaped conduits of constant section the paddles would be provided with a

shape corresponding to that of the transverse section of the conduit.

This invention provides a vehicle for use in conduits which is effective and efficient in operational use, which reduces maintenance costs, and which is modular in construction allowing it to be used with different means for removing material from the conduit. It will be understood that a camera and light may be mounted to the vehicle for inspection purposes. The device may be economically constructed and has an overall simple design which minimizes manufacturing costs and maximizes performance.

BRIEF DESCRIPTION OF THE DRAWINGS

Further aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

Figure 1 is a pictorial view of a first embodiment of the conduit cleaning apparatus of the present invention;

Figure 2 is a detail of the forward member of the apparatus of Fig.1;

Figures 3a and 3b are details of the rearward member of the apparatus of Fig.1, and

Figure 4 is a pictorial view of a second embodiment of the conduit cleaning apparatus of the present invention.

BEST MODES FOR CARRYING OUT THE INVENTION

Fig. 1 illustrates a first embodiment of the conduit cleaning apparatus which generally comprises a forward member 1 having a hydraulic cylinder 2, and a rearward member 3 having a rod 4 received in the cylinder 2. A power actuated wall-engaging mechanism (described further with reference to Figs 2, 3a and 3b) is provided on

both the forward and rearward members 1 and 3 for extending and retracting feet 5' and 5 respectively for selectively engaging the inner wall of a conduit 14 (see Fig. 2) to hold the members stationary. By coordinating the engagement and disengagement of the feet 5, 5' with the movement of the forward and rearward members 1, 3 by the hydraulic cylinder 2 and rod 4, the apparatus may propel itself in a stepwise manner through the conduit 14.

A rotary cutter 6 mounted at the front of the forward member 1 on a hydraulic motor 7 is provided for loosening material accumulated in the conduit 14. For removing the loosened material a vacuum is drawn through an evacuation tube 24 connected to the outlet pipe 9 on the forward member 1 which draws in the material through the opening 8 formed at the base of the plate 25.

Referring also to Fig. 2, the wall-engaging mechanism on the rearward member 3 includes three legs 10 to which respective feet 5 are pivotably fixed. Each leg 10 extends generally radially and is fixed by pins 11 for pivoting movement between a retracted position (Fig. 2) and an outwardly extended position (shown in dashed outline in Fig. 2) for engagement with the wall of the conduit 14. A spring 12 for biasing the legs 10 to the retracted position and a linear actuator 13 for extending the legs contact opposing sides of a radially inner end of each leg 10. Hydraulic fluid is supplied to the actuator 13 through the flexible hose coil 15 extending from the forward member 1. In the extended position it will be understood that the force F applied to the rearward member 3 (e.g. when the forward member 1 is being driven forward) provides a "self-servo" action increasing the frictional engagement between each foot 5 and the conduit 14.

Figs. 3a and 3b show the wall-engaging mechanism 20 provided for extending the feet 5' on the forward member 1 while simultaneously retracting the wheels 17, and vice versa. The three feet 5' are radially spaced about the cylinder 2 and are each pivotally mounted on radially extending pivoting legs 18. Associated with each of the

legs 18 is a pivoting arm 19 (lying generally in the same radial plane as the respective arm 18) to which a pair of wheels 17 are fixed to support the forward member 1 when the forward set of feet 5' are retracted. The mechanism 20 is actuated by a hydraulic ram 21 having an annular piston 22 ringing the cylinder 2 and fixed thereto for sliding relative to a cylindrical housing 23. Pressurising the hydraulic fluid on either side of the piston 22 displaces the cylindrical housing 23 up or down the cylinder 2 for extending and retracting the feet 5' and wheels 17. The linkage 20 includes a yoke 35 pivotally connecting each leg 18 and arm 19. A fork 36 pivotally connects the yoke 35 and the cylindrical housing 23.

Water jets 33 extending from the plate 25 direct a water spray (not shown) at the cutter blade 34 for lubrication, cleaning and aiding removal of the loosened material. Water is supplied to the forward member 1 in a hose (not shown).

The apparatus is connected by control cables (not shown) to a remote controller (not shown) connected to the valve block 38 which incorporates the control valves governing each operation of the apparatus. Together with the control cables, water hose and evacuation tube 24 elongate hydraulic supply and return lines, (not shown) connect the forward member 1 to a remote power source (not shown).

In operation, the apparatus may be stepped through the conduit 14 drawing the hydraulic lines and cables etc behind it until it reaches an obstruction.

With the front set of feet 5' retracted and the wheels 17 extended to engage the wall of the conduit 14, the actuator 13 is operated to lock the rearward member 3 in position. The end of the cylinder 2 opposing the rod 4 is then pressurised to extend the rod 4 and drive the forward member 1 in the forward direction.

The hydraulic ram 21 is operated to fix the forward member 1, retracting the wheels 17 and extending the front set of feet 5'. When the rearward member 3 Is released a return spring (not shown) retracts the rod 4 (or , in a double-acting arrangement the

rod end of the cylinder 2 is then pressurized to retract the rod 4) to draw the rearward member 3 in the forward direction.

The valve block 38 includes a control valve (not shown) for automatically reversing the direction of travel of the rod 4 when it reaches the end of its stroke for controlling its reciprocating movement. Solenoid operated valves (not shown) control operation of the rams 13 and 21 for selectively engaging the feet 5, 5', the timing of which in cooperation with the reciprocation of the rod 4, controls the direction of travel.

When an obstruction is reached, the rearward member 3 is fixed and with the wheels 17 extended the cutter 6 is driven forward to loosen and remove the material encountered. A pressure sensing valve (not shown) reacts to an increase in pressure at the hydraulic motor 7, to reduce the rate at which the cutter 6 is advanced. The apparatus can be removed from the conduit by reversing the stepwise mode of travel described above.

A second embodiment of the invention shown in Fig. 4 is like the first embodiment but includes an alternative to the vacuum pipe 9 and evacuation tube 24 for removing the loosened material. An auger 26 (driven, for example, by a hydraulic motor (not shown)) transports the loosened material from the opening 8 to the rear of the rearward member 3. A plurality of paddles 27, 27' are fixed on a shaft 28 connected to the rearward member 3 by a hydraulic ram 37. The ram 37 is provided for reciprocating the paddles 27, 27' and includes the rod 39 extending parallel to the shaft 28 to which the cylinder 38 is fixed. The paddles 27, 27' are fixed to the shaft 28 and spaced apart by a distance approximately equal to the stroke of the ram 37. Each paddle 27, 27' is freely pivoted about a respective horizontal axis X for movement between the upright position shown and a rotated position (not shown) where it is rotated in direction C.

The paddles 27 and 27' have semicircular and circular blades respectively that are

sized for sliding engagement with the walls of the conduit 14. Stops (not shown) limit the rotation of the paddles 27, 27' past the upright position shown, in the direction opposite to direction C. On paddles 27 rollers 29 extend from the front face 31 to lift the paddles 27' over the auger 26. Guide wheels 30 are fixed near the top of each paddle 27' to engage the wall of the conduit 14. Each paddle 27, 27' has opposing front and rear faces 31 and 32 respectively.

In operation, the shaft 28 and paddles 27, 27' are reciprocated (e.g. with the forward member 1 fixed to the conduit 14) in order to extract the loosened material. As the front face 31 contacts the material to be extracted while being drawn forward in direction F, the paddles 27, 27' are pivoted in direction C allowing the bottom edge of the paddles 27, 27' to ride up over the material (further assisted on paddles 27 by the rollers 29 engaging the auger 26). When moved rearward the material contacts the rear face 32, rotating the paddle 27, 27' to the upright position and transporting the material rearward. In this way material is transferred between adjacent paddles 27, 27' during successive strokes.

Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope thereof.

Colin Brian Nicholson

by his Attorneys

JAMES & WELLS

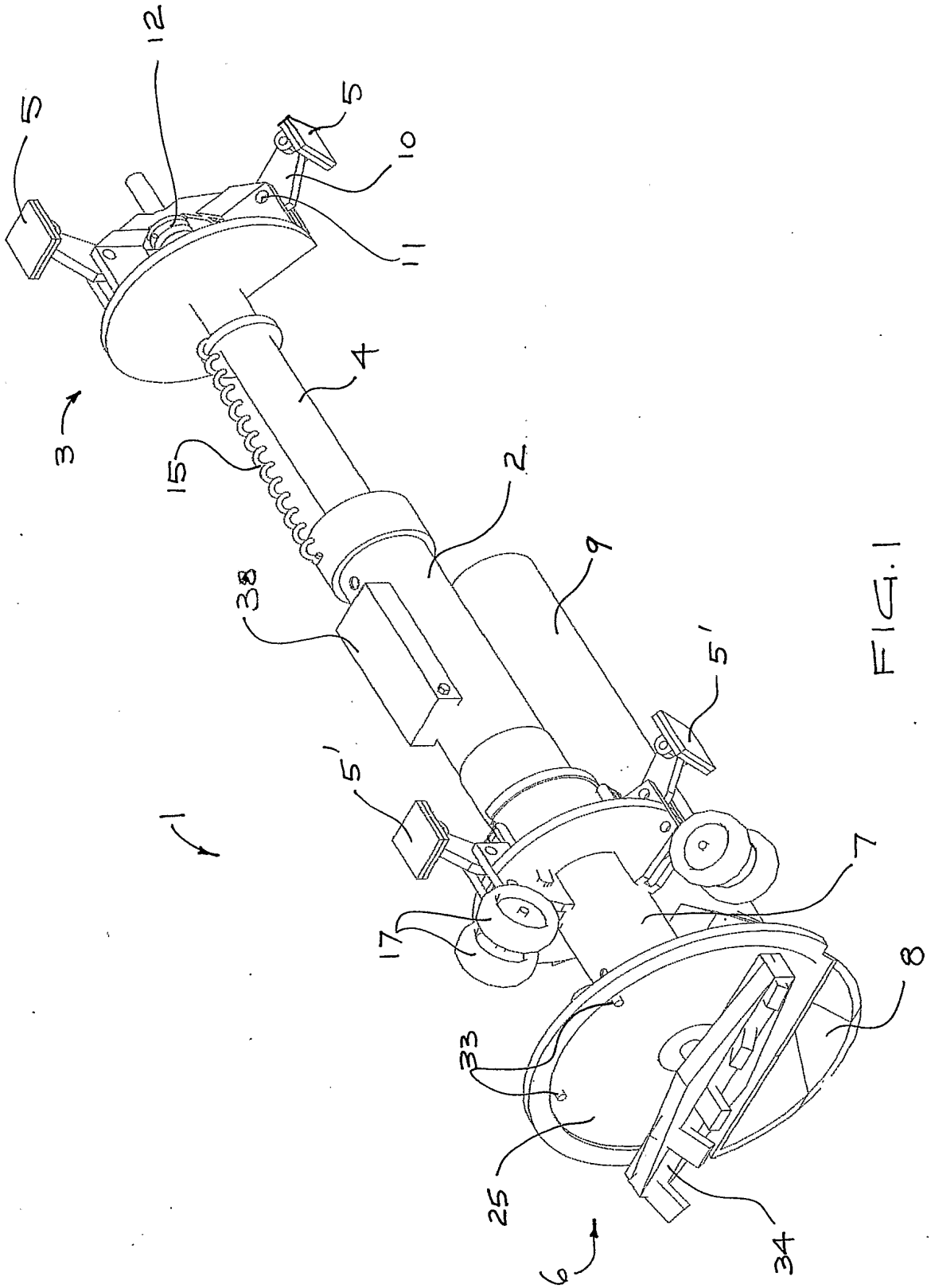

FIG. 1

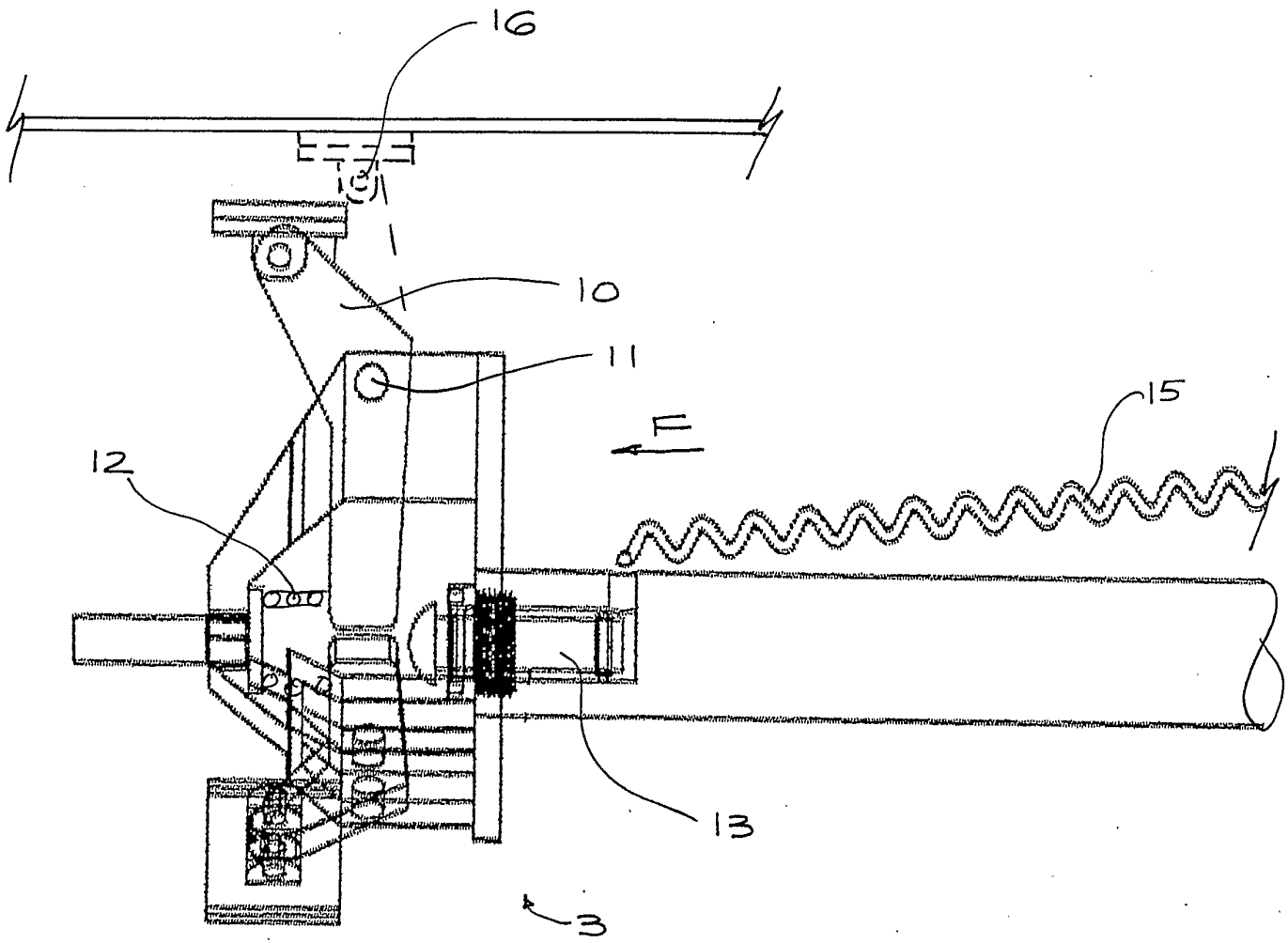

FIG. 2

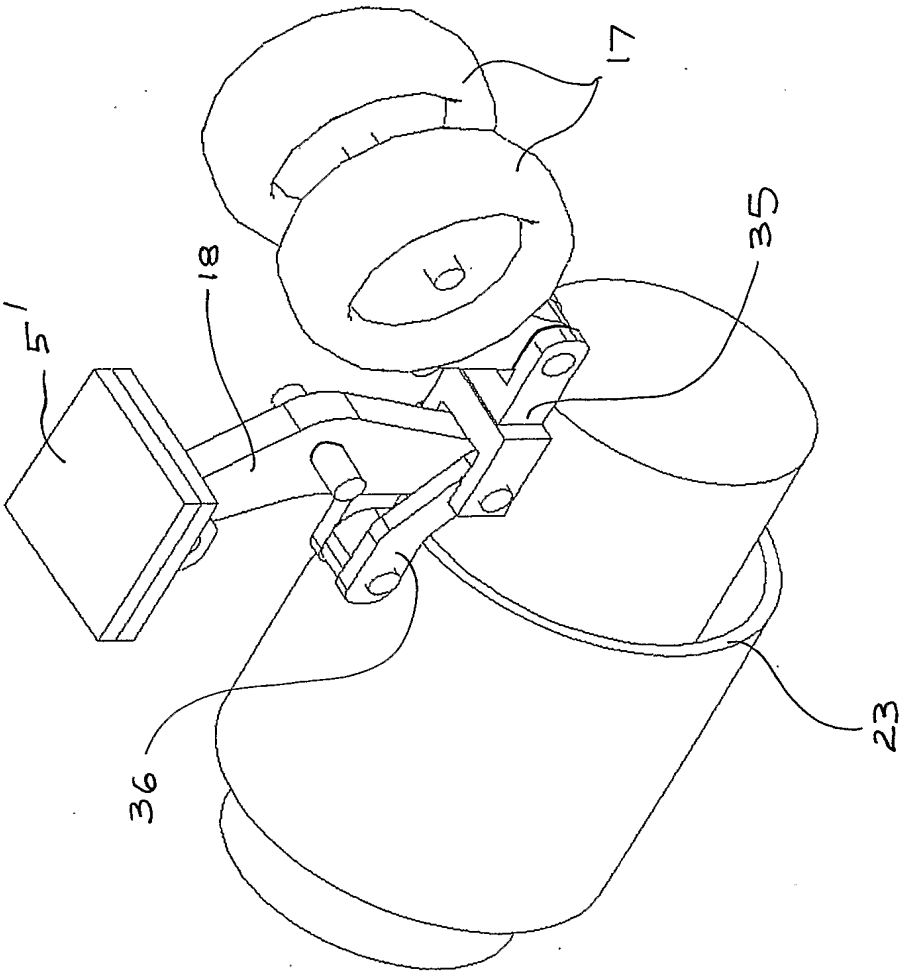

FIG. 3b

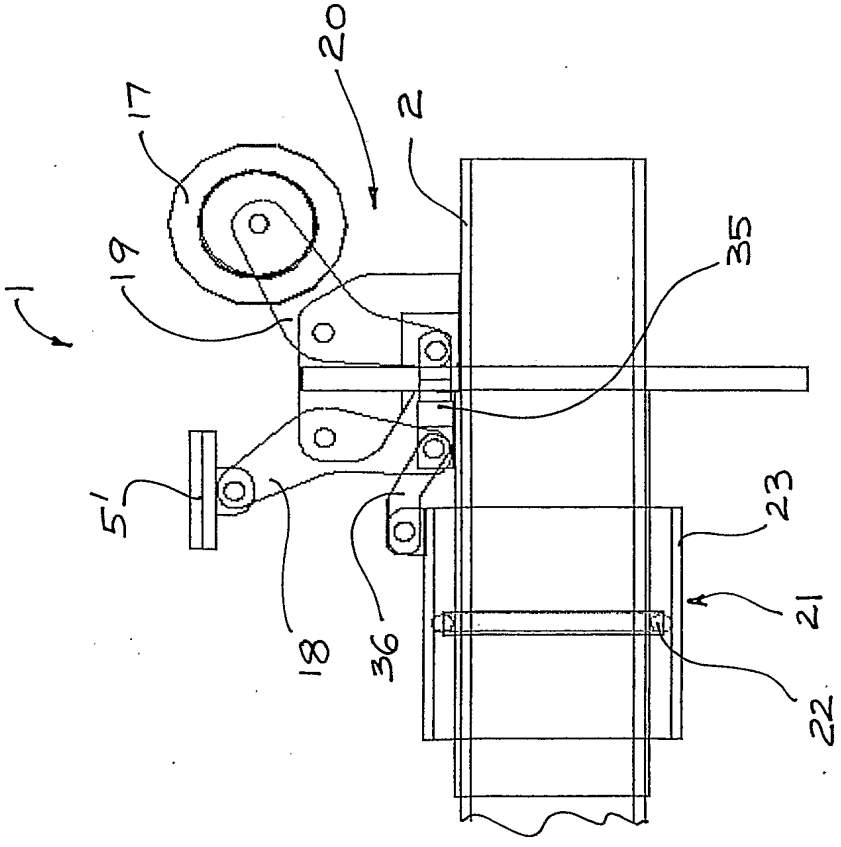

FIG. 3a

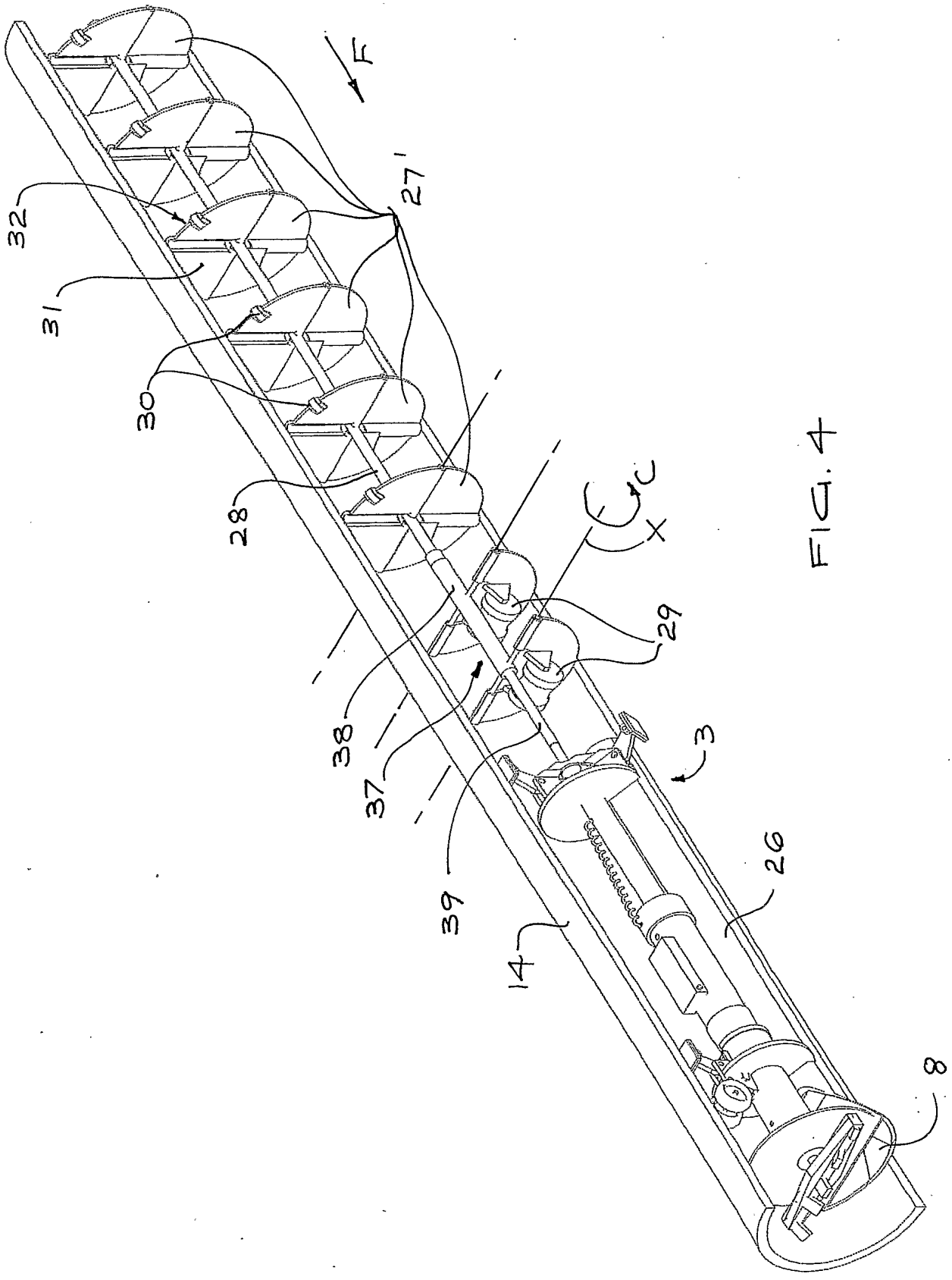

FIG. 4